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Improving Co-free oxygen electrodes for solid oxide cells through surface modification

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Solid oxide cells (SOC) are highly efficient, electrochemical devices for conversion of electrical to chemical energy and vice versa. The ongoing trend in the industry towards operating at so-called intermediate temperatures (IT-SOC) requires new solutions in the fabrication of highly electrochemically active, but also stable materials. Commonly used as oxygen electrode in IT-SOC are cobalt-containing mixed ionic-electronic conductors (MIEC), e.g. strontium-doped lanthanum cobaltite (LSC), which seems to be preferred by many developers these years. However, this material has several issues. One is segregation of dopants (e.g. Sr) causing loss of activity. Another is the use of Co, which is carcinogenic.

Recently, many studies emphasized the importance of surface chemistry for materials performance, since the smallest changes in ionic ratios can lead to large improvement or deterioration [1–4]. A notable example is the observation by Crumlin et al.[5], where authors reported improvement of oxygen exchange by 3 orders of magnitude by adding a small amount of Ruddlesden-Popper phase on the surface of LSC.

This study focuses on strontium doped lanthanum ferrite (LSF), a Co-free MIEC material which is stable in both oxidizing and reducing atmospheres, but often lacks the activity of Co-containing counterparts. We modify the surface chemistry of LSF through the addition of various ions by wet chemical route. The connection between surface chemistry analyzed by X-ray photoelectron spectroscopy (XPS) and electrochemical performance assessed by impedance spectroscopy is discussed and strategy for further improvement is proposed.

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